ENGINEERS AUSTRALIA

Western Australia Division

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CAPE LEEUWIN AND CAPE NATURALISTE LIGHTHOUSES
GUIDING LIGHTS FOR WEST COAST AND NATIONAL SHIPPING

NOMINATION OF

FOR

ENGINEERING HERITAGE RECOGNITION

Cape Leeuwin Lighthouse

Cape Naturaliste Lighthouse
(photos: Fiona Bush)

PREPARED BY ENGINEERING HERITAGE WESTERN AUSTRALIA

ENGINEERS AUSTRALIA

WESTERN AUSTRALIA DIVISION

Table of Contents

1. Introduction

This nomination pertains to the following structures:

Cape Leeuwin Lighthouse, Quarters and associated Water Wheel (1896)
Cape Naturaliste Lighthouse and Quarters (1903)

The Cape Leeuwin and Cape Naturaliste lighthouses, located within approximately 100 kilometres of each other on the south-western coast of Western Australia, were important links in the development of coastal lights that eventually circled mainland Australia. These are two of the remaining four intact and operating stone lighthouse structures on the west coast; the other two are on Rottnest Island near Perth (Wadjemup, 1894, and Bathurst, 1900). All other operating lighthouses in Western Australia were fabricated from steel, concrete and brick. The main Rottnest lighthouse (Wadjemup) was awarded an Historic Engineering Marker by Engineers Australia in 1996 [18].

The lighthouses were built to support coastal shipping in general, making it safer and more reliable, which encouraged the development of local industries and subsequent growth and prosperity of communities. The lighthouse system in the south-west (dominated by the Cape Leeuwin and Cape Naturaliste lights) was instrumental in the growth of the timber industry in that region, which relied on ships to transport the heavy cargoes. It also guided ships travelling from Europe to the eastern colonies, warning them of the hazards for vessels passing by the treacherous south-west corner of the continent.

Figure 1. The Cape Leeuwin Lighthouse precinct (Photo: Fiona Bush)

Given the geographic proximity of the Cape Leeuwin and Cape Naturaliste lighthouses to each other, and their similar purpose, operation and social and economic impact, it is proposed to nominate both together, with markers to be placed at each site. As these lights formed part of a critical network of lights surrounding the continent, and the Cape Leeuwin light in particular was essential for the safety of vessels travelling from Europe to the eastern colonies (or eastern 'States' after 1901), and they are examples of key developments in lighthouse technology, recognition of the level of EHNM is proposed.

Today, the lights continue to operate for the benefit of coastal shipping and leisure-craft. The precincts are tourist attractions greatly valued by the local communities of the area.

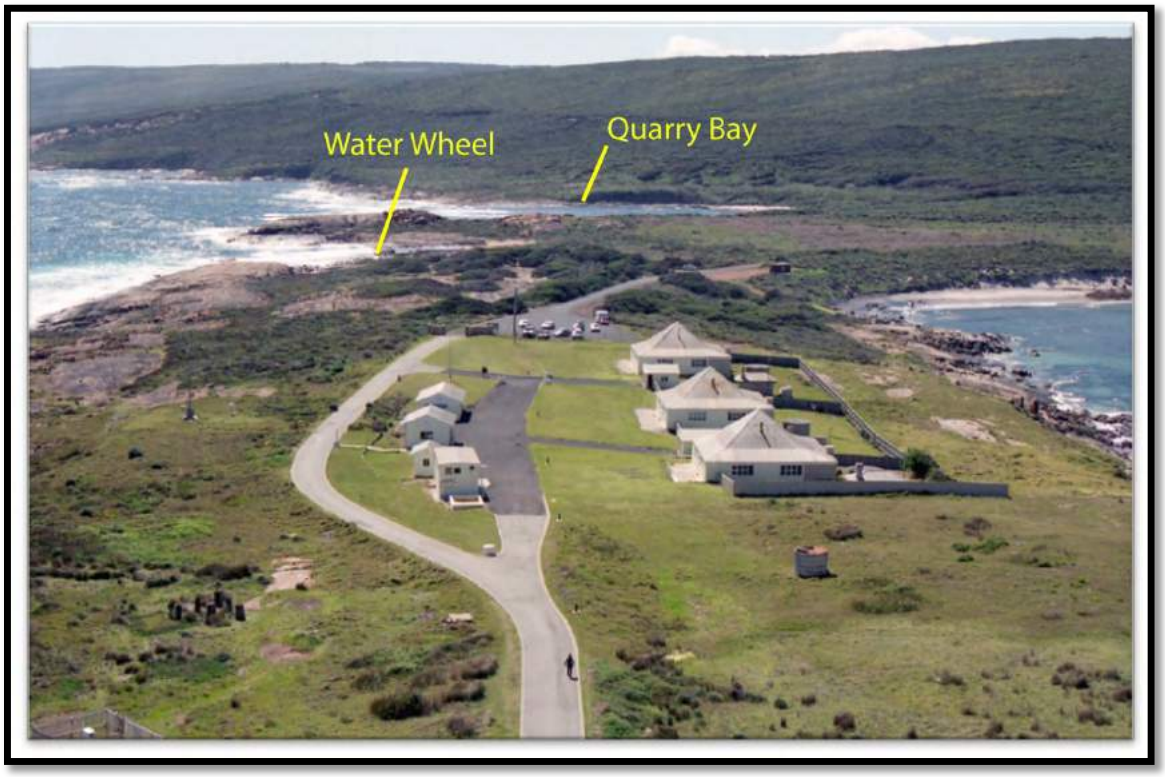

Figure 2. The Cape Leeuwin precinct viewed from the top of the lighthouse, looking north. The Indian Ocean is to the left, the Southern Ocean to the right. The bay in the distance is Quarry Bay, the source of some of the stone used in the construction [15]. The waterwheel and pump are located on the beach in the small inlet just to the south of Quarry Bay. (Photo: Fiona Bush)

Figure 3. The Cape Naturaliste Lighthouse precinct. (Photos: Left - Frances Andrich, Right - Fiona Bush)

2. Nomination Letter and Owner's Letter of Agreement

Learned Society Advisor
Engineering Heritage Australia,
Engineers Australia
Engineering House
11 National Circuit
BARTON, ACT 2600

Name of work:
Cape Leeuwin and Cape Naturaliste Lighthouses - Guiding Lights on the Western Coast

This work is nominated for an *EHNM* award under the Heritage Recognition Program of Engineers Australia.

Location:

Leeuwin Road, Cape Leeuwin, Western Australia
Cape Naturaliste Road, Cape Naturaliste, Western Australia

Owner:

Western Australian Government, Department of Biodiversity, Conservation and Attractions (formally Department of Parks and Wildlife).

The owner has been advised of this nomination and a letter of agreement is attached.

Access to site:

Sealed road access via roads indicated above.

Nominating Body: Engineering Heritage Western Australia

Chair

Karen Riddette

Date: 4 September, 2018

Government of Western Australia
Department of Parks and Wildlife

Your ref:
Our ref: CEO1983/15
Enquiries: Peter Henderson
Phone: 9725 4300
Email: peter.henderson@dpaw.wa.gov.au

Mr Ian Maitland
Chair, Engineering Heritage Western Australia
712 Murray Street
WEST PERTH WA 6005

Dear Mr Maitland

ENGINEERING HERITAGE RECOGNITION OF "EASTERN RAILWAY DEVIATION" (JOHN FORREST NATIONAL PARK) AND "SOUTH-WEST LIGHTHOUSES – CAPE LEEUWIN AND CAPE NATURALISTE"

Thank you for your email and attached letter dated 2 July 2015 regarding the successful engineering heritage recognition of the Eastern Railway Deviation through John Forrest National Park and the proposed nomination of the Cape Leeuwin and Cape Naturaliste lighthouses for similar recognition.

The Department of Parks and Wildlife congratulates Engineering Heritage Western Australia on its successful nomination of the Eastern Railway Deviation for heritage recognition by the *Engineering Heritage Recognition Program*. I am pleased to note that you are working closely with Mr Benson Todd to develop suitable interpretation and place the *Engineering Heritage Marker*.

Cape Leeuwin and Cape Naturaliste lighthouses have significant heritage, landscape, community and tourism values. Engineering heritage recognition, along with appropriate interpretation, will enhance these values. Parks and Wildlife is pleased to support your proposal for nomination of the lighthouses and if successful will assist with interpretation and a dedication ceremony.

The lighthouse precincts are managed on behalf of Parks and Wildlife by the Margaret River Busselton Tourism Association. I suggest you contact the CEO, Ms Pip Close to seek the association's comments and support. Ms Close can be contacted via the association's website at margaretriver.com.

I wish you all the best with the nomination and should you wish to discuss the operational aspects in more detail, please contact the department's Blackwood District Manager, Mr Wayne Elliott on 9752 5555 or by email at blackwood@dpaw.wa.gov.au.

Yours sincerely

Jim Sharp
DIRECTOR GENERAL

15 September 2015

Office of the Director General
Locked Bag 104, Bentley Delivery Centre, Western Australia, 6983
Phone: (08) 9219 9000 Fax: 9219 9967
www.dpaw.wa.gov.au

NOTE: In 2018 the Department of Parks and Wildlife became the Department of Biodiversity, Conservation and Attractions.

3. Heritage Assessment

3.1 Basic Data

Other/Former Names: N/A

Location:

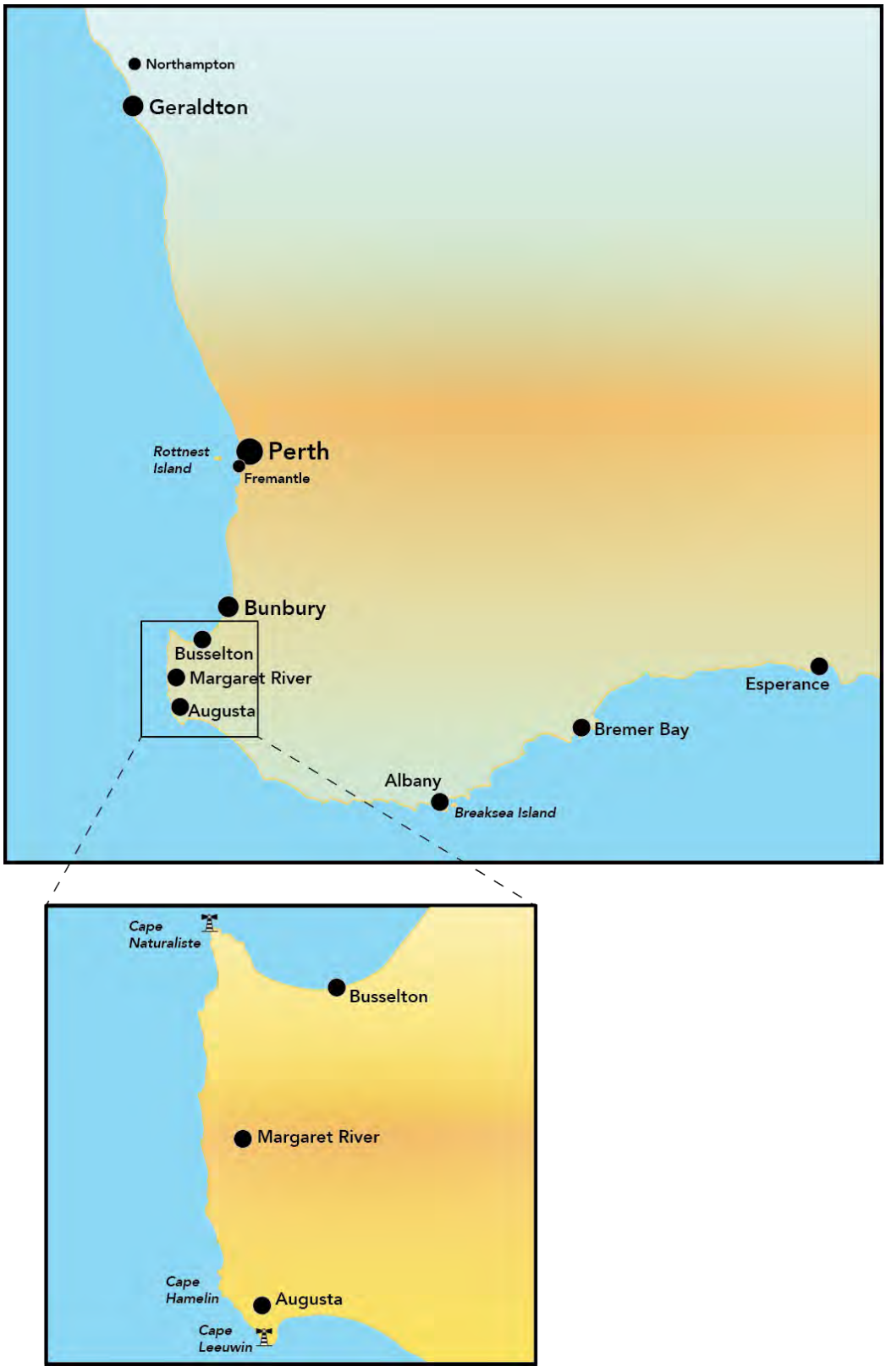

Figure 4. Location Map

Address: Suburb/Nearest Town:

Leeuwin Road, Cape Leeuwin, near Augusta, Western Australia

Cape Naturaliste Road, Cape Naturaliste, near Dunsborough, Western Australia

State: Western Australia

Local Govt. Area:

Cape Leeuwin: Shire of Augusta-Margaret River
Cape Naturaliste: City of Busselton

Owner: Western Australian Government, Department of Biodiversity, Conservation and Attractions.

Current Use:	Coastal lights and tourist attractions
Former Use:	Coastal lights
Designer:	English consulting engineer, William T Douglass (Leeuwin) West Australian Engineer-in Chief, C S R Palmer (Naturaliste)
Maker/Builder:	Maurice Davies and John Wishart (Leeuwin) WA Department of Harbours and Rivers (Naturaliste)
Year Started:	1895 (Leeuwin), 1903 (Naturaliste)
Year Completed:	1896 (Leeuwin), 1904 (Naturaliste)

Physical Description:

Both precincts include the operating light tower, keepers' quarters and other associated out buildings, a Visitors' Centre and museum. The lighthouses retain much of the original equipment, including the lenses, but the illumination and motor drive systems were upgraded to electric operation (see Modification dates below) and adapted for automatic operation. Close to the Cape Leeuwin lighthouse is the remains of a water-wheel driven pump that supplied fresh water to the keepers' quarters. Comprehensive interpretation is provided at both sites.

Physical Condition:

The condition of all light-station buildings and equipment is excellent. Visitors can see the original Chance Brothers lens and mercury bath floatation systems in position and operating, and can observe how the light system was updated to electric operation and subsequently automated.

The waterwheel at Cape Leeuwin is not operational, being covered with a heavy coating of limestone precipitated from the water supply to the wheel. However, the remains of the original wheel mechanism and the pump are visible.

Modifications and Dates:

The lighthouse structures are in their original condition. Lightroom equipment has been modernised at various times:

Cape Leeuwin Lighthouse:

1900 - 6 wick oil burner replaced by single kerosene mantle

1925 - kerosene mantle replaced by a cluster of 3 mantles fuelled by vaporised kerosene

1982 - light converted to electric operation and clockwork mechanism replaced by electric motor

Cape Naturaliste Lighthouse:

1924 - oil burner replaced by kerosene mantles fuelled by vaporised kerosene

1978 - light converted to electric operation and clockwork mechanism replaced by electric motor

3.2 History

A brief history of both lighthouses is included here. For further details of the history of both lights, and more on the Cape Leeuwin lighthouse in particular, please refer to the accompanying paper: 'CAPE LEEUWIN LIGHTHOUSE – A GUIDING LIGHT IN THE WEST FOR EAST COAST SHIPPING', Fiona Bush and Mark Bush, 19th Australian Engineering Conference, 2017.

Established in 1829 (as the Swan River Colony), Western Australia was very slow to construct lighthouses along its coastline in comparison with the eastern colonies. In contrast with the other colonies, Western Australia was established as a free settlement with little financial assistance from the British Government.

The justification for a lighthouse was directly linked to the amount of shipping in any given area. The first lighthouse erected in Western Australia was on Rottnest Island. Henry Trigg, the superintendent of colonial works, began work on that lighthouse in 1842 but it was not until 1851 that the building was completed [1]. The light served the main port of Fremantle, near Perth. The colony's second light was constructed on Breaksea Island, near the port of Albany (Fig. 4), in 1858 [2].

Augusta (near Cape Leeuwin - See Fig. 4) was first occupied by Europeans in May 1830, by settlers who arrived aboard the *Emily Taylor* [3]. By 1834, the majority of these settlers had moved north to Busselton where farming conditions were considered to be less harsh [4]. A second wave of settlers arrived in the Augusta region in the 1860s [3].

The presence of tall stands of timber tempted some of the early settlers to establish a timber industry. However, Augusta's isolated location made this resource difficult to exploit. It was not until Maurice Coleman Davies settled in Augusta in the 1880s, that the timber industry became a major force in the district. Davies established a number of mills in the area and constructed a tramway between his mills. Jetties were established at Hamelin Bay (used in summer) and Flinders Bay (used in winter) [3]. A number of small townships grew up around the timber mills including Karridale, Boranup, Hamelin and Jarrahdene [3]. Davies grew up on the Victorian goldfields and became a building supplier and contractor. He moved to Adelaide where he went into partnership with John Wishart. In 1875 Davies moved to Western Australia where he established his timber milling business [5]. Davies saw a need for a light near the south-west cape as his timber mills exported large quantities of timber from ports in this area. He began urging for the construction of a light in 1881 [3].

At the national level the need for a light on the south-western corner of Australia to protect shipping travelling from Europe to the eastern colonies was recognised as early as 1873, during the Inter-Colonial Conference on the Care and Management of Coastal Lights. At this conference, two new lights were recommended for WA as being required for the benefit of Australian coastal shipping, one on Cape Naturaliste and the other at Cape Hamelin, near Cape Leeuwin (Fig. 4). The light proposed for Cape Hamelin was considered to be one of the *'lights maintained especially for the use of vessels of another colony'*, as it would be situated primarily to assist shipping passing by the south-west corner on its way to the eastern colonies.

Pressure from the timber industry in the early 1880's led the Premier of Western Australia, John Forrest, supported by the Legislative Council, to seek funding from the eastern colonies to build the light, as it would be mostly for the benefit of the eastern colonies. By that time it had been decided to place the light at the logistically more difficult Cape Leeuwin, as it would be a more effective position than Cape Hamelin for guiding shipping. However, funding from the east was not forthcoming [3]. In 1884 when Malcolm Fraser (former Surveyor General) represented Western Australia at the Australasia Conference held in Sydney, he remarked that a light at Cape Leeuwin would be most desirable, '*a work of Federal importance*.' He also noted that the

Western Australian government felt that the cost of incurring the sole expense of the erection of this light was unfair as it was agreed that a light at this cape would be beneficial to all colonial shipping [6]. However, as before, the eastern colonies were unwilling to assist. It was not until the 1890's that exploitation of gold resources in Western Australia provided the funds for the Colony itself to fund the lighthouse. The then Premier of Western Australia, John Forrest, laid the foundation stone for the Cape Leeuwin lighthouse in 1895 and returned for the official opening on 10 December 1896. The lighthouse structures were designed by British Consulting Engineer, William T. Douglass, and built by Maurice Davies and John Wishart [7-8]. The optical apparatus was designed and manufactured by Chance Brothers of the UK [9]. The tower is 39 m tall from ground to light, making it the tallest lighthouse tower on the Australian mainland today [10-11].

Increased shipping over the following years, associated with the growth of the agricultural industry around Busselton, led to increased pressure for the second light identified by the 1873 Inter-Colonial Conference to be built at Cape Naturaliste. However, by this time the Australian Federation had come into existence and had agreed that the Commonwealth would take over the construction, management and maintenance of lighthouses at a future time, which made the States reluctant to spend money on lighthouses. Despite this the Cape Naturaliste lighthouse project, funded by Western Australia, was confirmed in 1902. The lighthouse was opened in 1903, with further outbuildings completed in 1904.

As the lighthouse stands on a headland, it did not require the impressive height of the Cape Leeuwin tower, standing just 20 m tall from ground to light. The lighthouse design and construction was overseen by the then Western Australian Engineer-in-Chief, C. S. R. Palmer, who probably contributed to the design. The lantern room was designed by William T. Douglass, who was also responsible for design of the Cape Leeuwin lighthouse [12]. Palmer was in charge of the WA Department of Harbours and Rivers, the organisation charged with management of the construction. Construction was carried out by contractor Mr. Anderson. The optical apparatus was designed and manufactured by Chance Brothers of the UK [9].

On 1 July 1915 responsibility for the Cape Leeuwin and Cape Naturaliste lighthouses was transferred to the Commonwealth Government.

Both lights have operated continuously since they were opened. Cape Naturaliste was converted to automatic operation in 1978, Cape Leeuwin in 1992 [10]. The light-keepers' quarters at Cape Leeuwin were therefore occupied for almost 100 years.

Both sites were transferred from the federal Australian Maritime Safety Authority (AMSA) to the State of Western Australia in 2000, although AMSA retains responsibility for operation of the lights. The precincts are now the responsibility of the Department of Recreation, Conservation and Attractions, being State reserves. The quarters and lighthouses are operated as tourist attractions by the Margaret River Busselton Tourism Association.

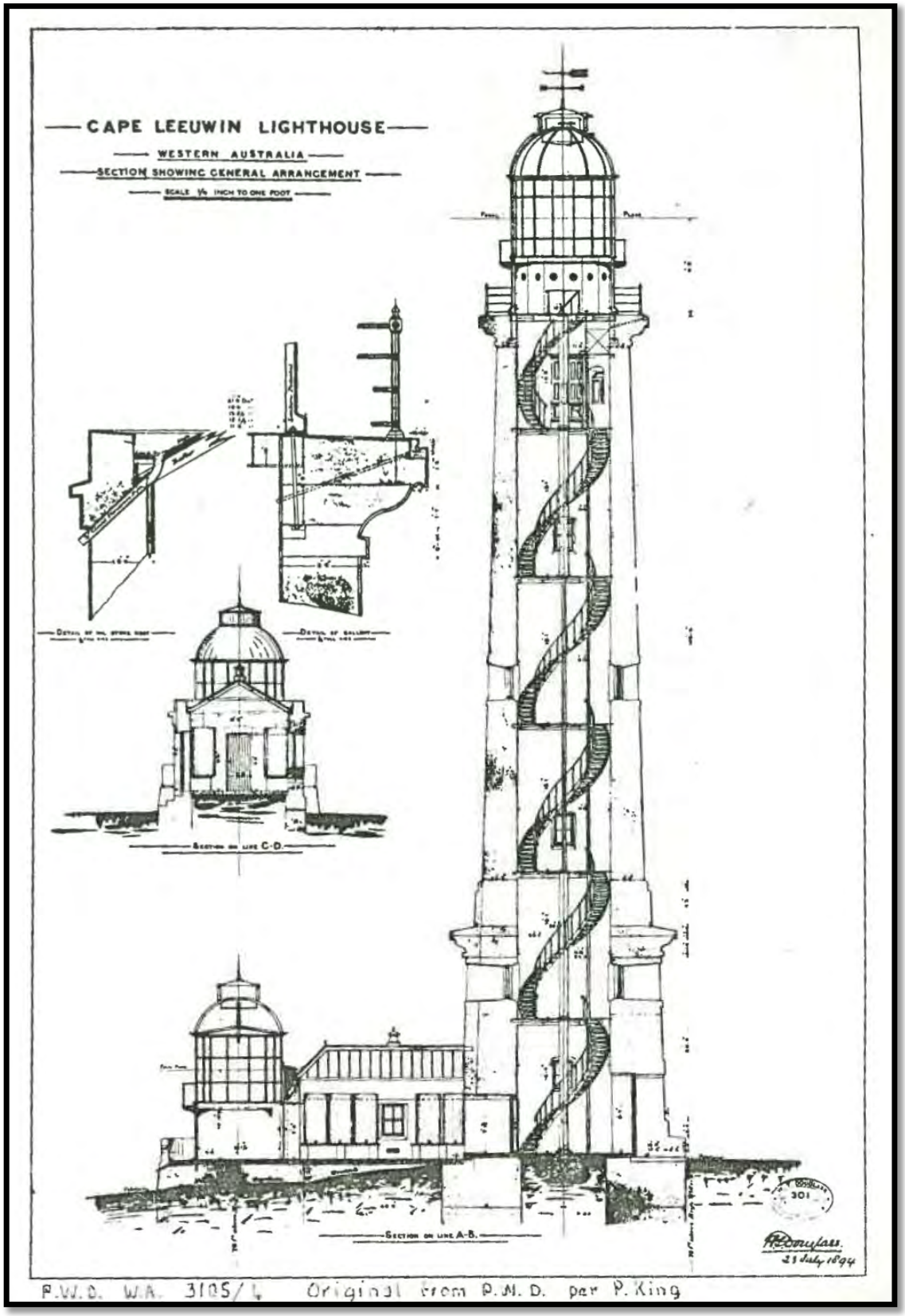

Figure 5. Design section drawings of the Cape Leeuwin lighthouse showing the general arrangement. The small lighthouse to the left was originally intended to show a red light, providing additional warning of the reefs. It was dropped from the final construction [12] (Image from [5]).

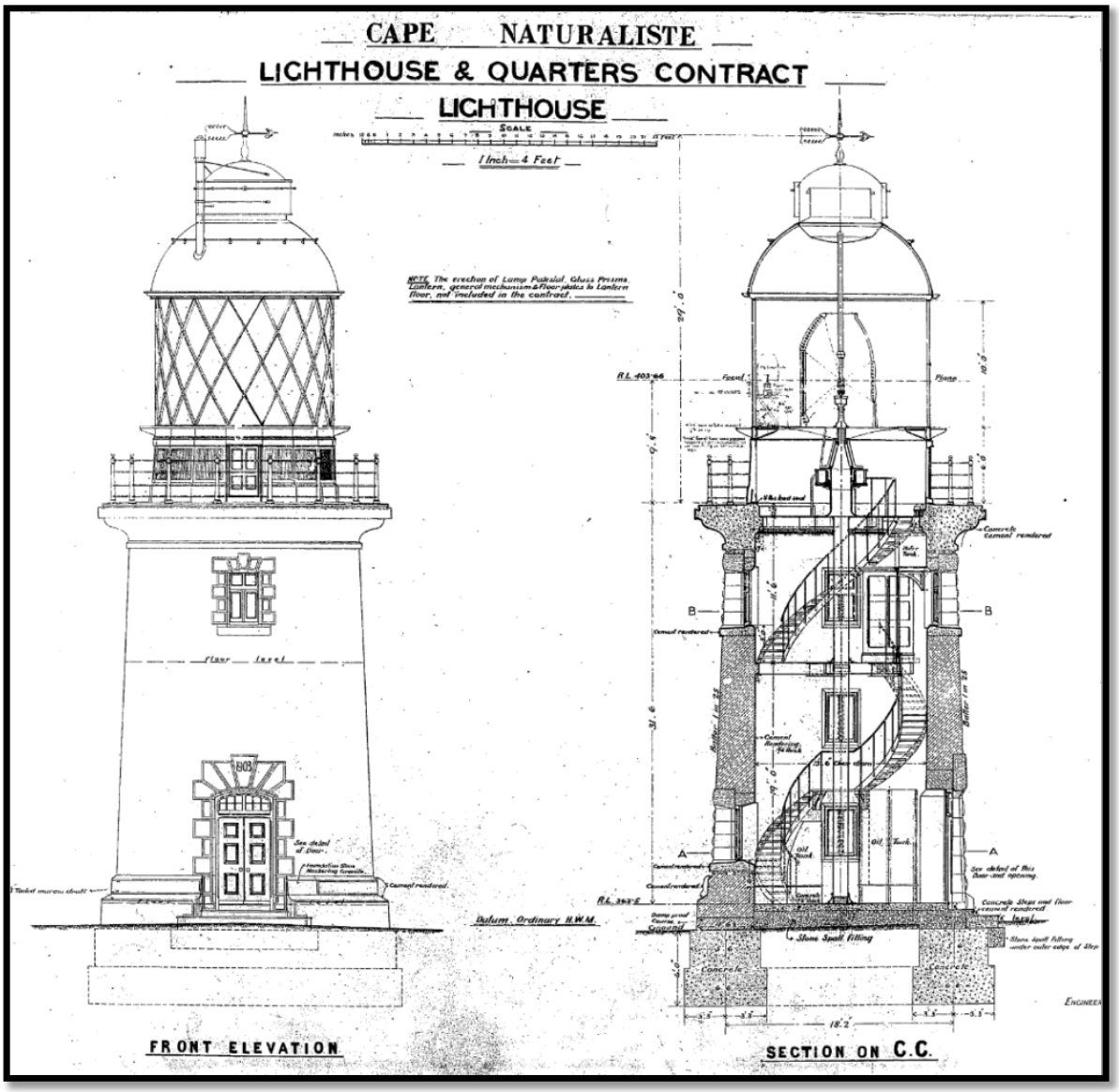

Figure 6. Elevation drawing of the Cape Naturalist Lighthouse
(image courtesy of Australian Maritime Safety Authority)

3.3 Heritage Listings

Cape Leeuwin Lighthouse and Quarters:

- Register of Heritage Places: 00104, *Cape Leeuwin Lighthouse and Quarters*, Permanent Entry 13/05/2005 (interim 1992)
- National Trust Classification: L/house 13/08/1973, Cottages 01/05/1978
- Town Planning Scheme (Augusta/Margaret River) Adopted 04/1985
- Municipal Inventory: Adopted 06/1996
- Register of the National Estate:
  9399, *Cape Leeuwin Lighthouse*, Registered 21/10/1980
  9401, *Cape Leeuwin Lightkeepers' Cottages*, Registered 21/10/1980

Cape Leeuwin Water Wheel:

- Register of Heritage Places: 00106, *Cape Leeuwin Waterwheel*, Permanent Entry 14/05/2002 (interim 2001)
- National Trust Classification: Recorded 11/06/1973
- Town Planning Scheme: Adopted 04/1985
- Municipal Inventory: Adopted 06/1996
- Register of the National Estate: 9412, *Water Wheel, Leeuwin Rd*, Registered 21/03/1978

Cape Naturaliste Lighthouse and Quarters:

- Register of Heritage Places: 02914, *Cape Naturaliste Lighthouse and Quarters*, Permanent Entry 17/04/2003 (interim 1992)
- Town Planning Scheme (Busselton): Adopted 04/1985
- Municipal Inventory: Adopted 12/06/1996
- Register of the National Estate: 16693, *Cape Naturaliste Lighthouse and Reserve*, Registered 18/4/1989

4. Assessment of Significance

4.1 Historical Significance

The construction of both lighthouses made shipping operations significantly safer, contributing enormously to the development of communities and the growth of commerce, particularly the timber industry. Both lights were identified as important to the development of the nation at the 1873 Inter-Colonial Conference, the Cape Leeuwin light having the highest priority.

Both lighthouses are constructed of stone, and are of similar overall design, but the scale of the two lighthouse towers is quite different. The Cape Leeuwin lighthouse is located on ground about 20 m above sea level. The tower is 39 m tall (measured from the foundation) to lift the light to an operational height, making it the tallest stone lighthouse in Western Australia and third tallest in Australia (but the tallest on the Australian mainland). The Cape Naturaliste lighthouse, measuring 20 m high, is positioned on a 100 m high bluff, so does not require the tower height of the Cape Leeuwin lighthouse.

The mercury bath flotation system installed to support the heavy lens assembly in the Cape Leeuwin Lighthouse was the first implementation of the technology by Chance Brothers, Cape Naturaliste following shortly thereafter. The technology was originally developed by French lighthouse engineers, but was quickly adopted and refined by Chance Brothers to produce the fastest flashing lights in the world, Cape Leeuwin being the fastest at the time (see Technical

Achievement). The mercury flotation system is still in operation in both lighthouses.

The precincts include the lighthouse towers and their equipment, living quarters for three Light Keepers and their families, offices, stables, laundries, etc, associated with the residences and operation of the lighthouses, and in the case of Cape Leeuwin, the remains of the waterwheel pump on the beach nearby. The sites also reflect more recent developments in the technology and operation of the light stations, such as fuel stores, powerhouses and radio huts built in the 1940s and later. Although the engineering significance is mostly contained within the light towers and waterwheel system (Leeuwin), the whole of each precinct is important as an example of a light-station as it was operated in the early 20th century.

Figure 7. The Cape Naturaliste Keepers' cottages. The lighthouse is a short walk from the cottages. The nearest cottage is the Visitors' Centre, the second is the museum. (Photo: Fiona Bush)

4.2 Historic Individuals

Sir John Forrest

John Forrest (1847-1918) was born in Bunbury, Western Australia. He trained as a surveyor and joined the staff of the Surveyor General's Office in 1865. In addition to his surveying work, during the next ten years he gained a widespread reputation as a capable and courageous explorer. In 1883 he was appointed Surveyor-General and Commissioner of Crown Lands and gained valuable administrative experience for seven years as an ex officio member of the Executive and Legislative Councils. When responsible government was granted to the colony by the British Government in 1890, he became the colony's first Premier and Treasurer, positions which he held without challenge for the ten years prior to the Federation of the Australian colonies to form the Commonwealth of Australia.

Forrest's policies as Premier focused on taking advantage of the mining boom to raise loans in London to finance the provision of public works for the colony. These were to be centred on Perth as the metropolis and allocated in a manner which balanced the needs of the metropolitan, agricultural, pastoral and mining regions, and which at the same time provided for the long-term future of the colony, which Forrest saw in terms of expanded agricultural production. Forrest strongly supported the installation of lighthouses in south-western Australia to support the development of the timber industry.

At Federation, Forrest was elected to the National House of Representatives as Member for Swan. He was prominent in the formation of the Liberal party (the Australian conservative party) and served as Treasurer in five ministries and was also Minister for Defence and Home Affairs. He was acting Prime Minister for three months in 1907.

Sir John Forrest was appointed KCMG (Knight Commander of St Michael and St George) in 1892 and GCMG (Grand Commander in the same order) in 1901.

(Photo: Web archive)

Charles Stuart Russel Palmer

As the Western Australian Engineer-in-Chief, C.S.R Palmer oversaw the design and construction of the Cape Naturaliste Lighthouse.

The following is a newspaper article published in The West Australian, 12 June, 1902, at the time of his appointment as Engineer-in-Chief, which was also the year in which the Cape Naturaliste Lighthouse project was approved to go ahead.

MR. C. S. R. PALMER APPOINTED.

At the meeting of the Executive Council on Wednesday, Mr. C. S. R. Palmer, te [sic] *engineer for sewage and town water supply, and wo* [sic]*, since the suspension of Mr. T. C. Hodgson, has been carrying out the duties of engineer in charge of the Goldfields Water Supply Scheme, was appointed to the position of Engineer-in-Chief, at a commencing salary of £1,000 a year.*

Mr. Palmer was educated in the Government Engineering College at Rurki, India, a college which is maintained especially for the training of officers for the Public Works Department of that country. He was the top man of the year 1878, and gained the gold medals for mathematics, and the best practical design, and also the prize for civil engineering. He entered the Public Works Department of India, as assistant engineer in October, 1878, and severed his connection with it on a retiring allowance in April, 1894. During the years 1885 to 1887, he was in England studying questions of water supplies, sewerage, and architecture under Sir Alexander Binnie, lately engineer of the London County Council, and M. Spiers, the Professor of Architecture at the Royal Academy, having been specially sent by the Government of India to acquire practical knowledge on these subjects. On his return, he was appointed assistant secretary for one year. This position is similar to that of Under-Secretary in this State. In India, however, it is essential, in consequence of different conditions, to select professional officers to fill these positions, and in order that the executive engineers may have a grip of the head office work. For a year also, Mr. Palmer was Assistant Engineer-in-Chief. During his last five years of service in that country, he was executive engineer, a position equivalent to that of engineer in charge of a branch in this State. Mr. Palmer came to Western Australia in 1894. and in October of that year joined the civil service, as an assistant surveyor in the Public Works Department; and, having passed through the railway construction branch, was appointed engineer for roads and bridges, and engineer for harbours and rivers in August. 1897. In August of the following year. he surrendered the charge of the harbours and rivers branch to another officer, and assumed the position of engineer for general water supply, in addition to the position of engineer for roads and bridges. During the seven months that Mr. James Thompson, the engineer for railway construction, was absent from the State on leave, Mr. Palmer took charge of that branch in addition to his own. This was at the end of 1900 and at the beginning of 1901; and in the latter year he was for three and a half months placed in charge of the Fremantle Harbour Works.

The following is a bio of CSR Palmer, published by the Institution of Civil Engineers (Cumming Papers, Engineers Australia)

PALMER, Charles Stuart Russel MICE b. 1858.

Educated at Rorki Engineering College, where he won the India Prize for the best student, Palmer joined the Public Works Department of India in 1878. Posted to Mandli Sub-Division, and in 1883 to Belul Sub-Division, he took charge of Khandwa Sub-Division in 1884. After two years in England during which he studied Architecture at the Royal Academy and Hydraulic Engineering with Sir A.R. Binnie, MICE, he returned to India in 1887 and worked on railway construction. Following appointments as Executive Engineer for Hoshangabad in 1887, and in charge of Nagpur Division in 1892, he left India and joined the Public Works Department of Western Australia in 1894. Soon appointed Engineer for Roads and Bridges as well as Engineer for Water Supply, he proposed a trial bacterial sewerage system for Government House in 1901, succeeded C.Y. O'Connor as Engineer-in-Chief in 1902, and was a member of the inter-state commission of Engineers on the Transcontinental Railway in 1903. In 1904, he returned to England to become Inspecting Engineer. His published papers include

'Engineer-in-Chief's report on Fremantle Harbour' MBEJ 28/11/1903;
'Coolgardie water supply' PICE 162, 1904-5, IV; and
'Fremantle harbour works' PICE 184, 1910-11, SC 1900, 1905.

'RSC retrenchment of Mr. H.W. Hargrave' V&P WA 1900, A24.
'RRC Coolgardie Water Supply' V&P WA 1902, 11.
'RSC Metropolitan Water Works' V&P WA 1902, A14.
MBEJ 1/8/1903 p.17.
'Proposed Trans-Continental Railway ... reports of Engineers-in-Chief' CA PP 1903 (22) p.1259.
'Reports on sewerage of Perth and Environs' V&P WA 1903-4, 25.
TAUM pp92, etc.
LPG pp287, etc.
HUNT pp16-21.
HAIEA.

Chance Brothers

Chance Brothers was the firm responsible for much of the development of lighthouse illumination technology deployed by the British Empire from the mid 19th century through to the mid 20th century [9].

James Timmins Chance, 1834. Portrait by J.C. Horsley. Royal Academy Collection.

Robert Lucas Chance (1782 – 1865), known as Lucas, bought a British Crown Glass Company's works in 1824. The company specialised in making crown window glass. The company ran into difficulty and its survival was guaranteed in 1832 by investment from Lucas' brother, William (1788 – 1856), who owned an iron merchant business in Birmingham. Lucas and William Chance became partners in the business, which was renamed to *Chance Brothers of Birmingham*. Chance Brothers projects included glazing the 'Crystal Palace' to house the Great Exhibition of 1851, and the Houses of Parliament built during the 1840s and 1850s, including the four faces of the Westminster Clock tower housing the 'Big Ben' bell.

James Timmins Chance (1814 – 1902), a son of William Chance, joined the family business and was senior manufacturing partner in the company during the period when steam ship driven commerce was growing, and advanced lighthouse technology became imperative to protect both life and cargo at sea. He was particularly interested in the science and technology of glass manufacture and lighthouse optics. The Great Exhibition of 1851 included a massive lighthouse lens conceived and built by James Chance. The lens stood 6 m high and consisted of 430 prisms, a major technical achievement for the time.

The key breakthrough enabling the construction of large lenses was not British in origin, but French. The French mathematician and optical scientist, Augustin Fresnel, first devised the 'dioptric' lens, consisting of a small central bullseye lens surrounded by a series of concentric segmented prismatic lenses arranged to capture the light emitted from a central light source (such as an oil burner) and redirect it into a parallel beam. The so called 'Fresnel lens' was a far more efficient and powerful alternative to the earlier beam systems based on reflectors arranged behind and around the light source (catoptric systems). In 1822 France adopted the Fresnel dioptric lens system for use throughout its lighthouse system.

The Fresnel lens design enabled later key developments in lighthouse lens technology, such as rotating the lens to produce a flashing light, the incorporation of multiple bullseyes to produce more rapid flashing (more than one flash per revolution); and uneven flashing per revolution, to give each lighthouse its own unique signature.

James Chance adopted the Fresnel lens for his 1851 Exhibition exhibit. Keen rivalry between the British and French optics manufacturers ensured rapid development of the technology, with Chance Brothers dominating the lighthouse optics business throughout the British Empire. Over the next 100 years, the company supplied more than 2,400 lighthouse lenses to nearly 80 countries, including the lens systems for the Cape Leeuwin and Cape Naturaliste lighthouses.

William Tregarthen Douglass (1857–1913)

William T. Douglas was an engineer, from a lighthouse engineering family. He was a consulting engineer for lighthouse construction for several governments around the world. His uncle William and his grandfather Nicholas were also famous in lighthouse construction. William T. Douglass designed the Cape Leeuwin lighthouse structures and the light-room for the Cape Naturaliste Lighthouse.

The following is an extract from an obituary to William T. Douglass, published by the Institution of Mechanical Engineers, 1913 [16]. (source - Grace's Guide to British Industrial History)

> *WILLIAM TREGARTHEN DOUGLASS was born at Solve, Pembrokeshire, on 23rd March 1857, being the son of the late Sir Douglass, who was for many years Engineer-in-Chief to the Trinity House. He was educated at Dulwich College and King's College, London, in the Applied Science Department.*
>
> *Having served his pupilage at the Trinity House for three years, from 1875 to 1878, under his father, and at the engineering workshops at Blackwall, he studied optics and the manufacture of optical apparatus at Messrs. Chance Brothers' lighthouse works, Birmingham, under the late Dr. John Hopkinson, F.R.S.*
>
> *From June 1878 to August 1882 he was resident engineer at the erection of the new Eddystone Lighthouse, and had sole charge of the works in connection with the removal of Smeaton's Tower.*
>
> *From 1882 to 1887 he was resident engineer in sole charge of the difficult work of strengthening and improving the Bishop Rock Lighthouse, Scilly Isles, and he erected a lighthouse on Round Island, in the same locality.*
>
> *He also carried out a large amount of engineering work of the same nature, and at the time of his death was consulting engineer to the Governments of Western Australia, New South Wales, and Victoria, and inspecting engineer to the Royal National Life Boat Institution, for which he designed their life-boat stations and slipways, etc.*
>
> *At Cromer he constructed the sea wall, and at Lowestoft his system of groynes was adopted by the local authority.*
>
> *In 1899 he was selected by the Secretary of State for India to inspect and report on the whole of the lighthouses of India and Burma, comprising ninety stations and covering an immense stretch of coast and river line. He was the author of several books on lighthouses, and on the lighting of estuaries and rivers.*
>
> *His death took place by drowning on 10th August 1913, at the age of fifty-six. While out with his son in a sailing-boat, the latter capsized when off Start Point, near Dartmouth, and sank. The son, who was picked up by a pleasure steamer, swam with his father for about three-quarters of a mile, when the latter became exhausted and was drowned, in spite of efforts made by his son to keep him afloat.*
>
> *He was elected a Member of this Institution in 1887; he was also a Member of the Institution of Civil Engineers, and a Fellow of King's College, London.*

Maurice Coleman Davies (1835-1913)

Maurice Davies was a driving force behind much of the development of the timber industry in the Busselton, Bunbury and Augusta regions of Western Australia. He had a long-standing partnership in building with John Wishart (see below) and together they built the Cape Leeuwin lighthouse and the water wheel system. The following is extracted from the Australian Dictionary of Biography [17]:

> *Maurice Coleman Davies, timber merchant, building contractor and pastoralist, was born in London, son of John Davies and his wife Catherine, née Hart (1795-1889). At 5 he went to Van Diemen's Land with his parents, who took up pastoral pursuits. After some eleven years he went to Victoria and worked on the Blackwood diggings. He then engaged in a mercantile and shipping business in Melbourne and later in Adelaide, where in 1867 he opened as a general commission agent and merchant in Gilbert Place. When he moved to Grenfell Street in 1877, he was dividing his time between South and Western Australia. As a member of Baillie, Davies & Wishart in South Australia he carried out several government contracts. One of them, for the second section of the Melbourne-Adelaide railway, introduced Davies to Western Australian hardwoods, and on Christmas Eve 1875 in Perth he applied for a lease of 1920 acres (777 ha) of forest in the Bunbury district. In 1876 he set up a steam sawmill in the Collie Ranges, about twenty miles (32 km) from Bunbury. The Collie mills operated successfully for eight years. Private visitors and government officials were favourably impressed with the efficiency of his station and, although Davies disputed with local authorities over the upkeep of roads used by his horse and bullock teams, an official investigation left no doubt that Davies's operations greatly benefited the district. For several years until 1878 he was also a shareholder in the Jarrahdale and Rockingham Timber Co.*
>
> *By 1877 he was interested in the timber between Cape Hamelin and Augusta in the extreme south-west. He took up a licence to cover the area and began cutting in 1879 in what became the Karridale estate; there in the 1880s and 1890s he built several large mills, townships, roads, railways and jetties, and installed a telephone system, library and sports ground. He shipped timber from Hamelin Bay on the west coast, and Flinders Bay on the south coast.*
>
> *M. C. Davies was one of the handful of men whose career bridged the pioneering phase of Western Australian timber industry, the boom of the 1890s and the consolidation of the early twentieth century. His financial rewards were a measure of his skill as a timberman; none before him had worked Western Australia's forests so successfully and on such a scale. His greatest contribution to the colony's development was probably his promotion of karri. His efforts to bring it to the notice of buyers included showing it at the Indian and Colonial Exhibition in London in 1886 and at Melbourne in 1888 where he won a trophy. He and his sons travelled widely in their attempts to open new markets for karri. At times his business practices were criticized; his company was detected selling karri as jarrah for marine works, and several controversies arose over the alleged leniency of the government's terms when granting him timber licences. But he rose high in the social scale of the colony. His burial in the Jewish section of Karrakatta cemetery was attended by representatives of many leading families.*

John Wishart (1835-1906)

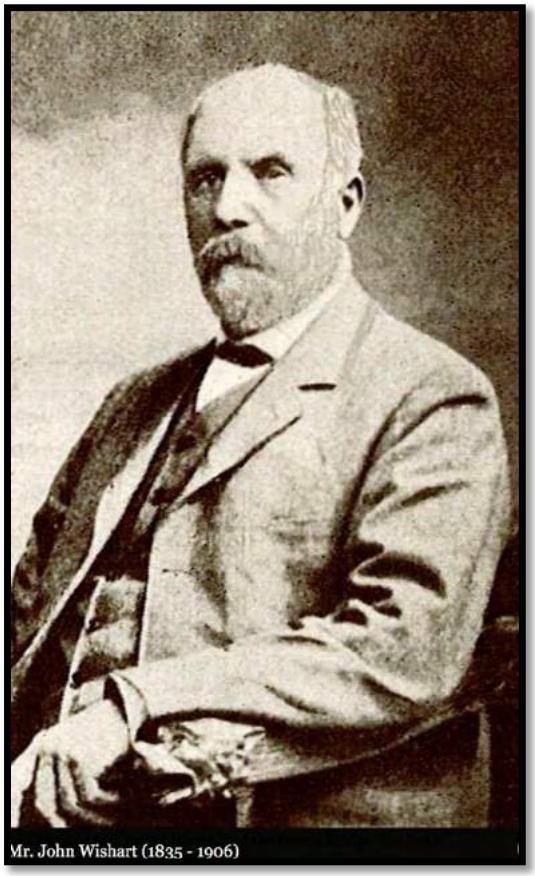

Photo:wishartconnections.org.

John Wishart built the Cape Leeuwin lighthouse and quarters in partnership with Maurice Davies (see above). The following is an obituary extracted from the Cyclopedia of Fiji, Fiji Museum (1984):

THE late MR. JOHN WISHART, Sen., was born at Stromness, Orkney Islands, in September, 1835, and resided there till about twenty years of age. He then went to Victoria, and worked on the gold-fields for some time, shortly afterwards commencing business as contractor. In 1865 he left Victoria for South Australia, where he resided until he came to Fiji, in April, 1901. Since commencing business he had by himself and with partners carried out large works of varied descriptions the principal being in South Australia. These include the second section of the Intercolonial railway, from Mount Lofty to Nairne. This is a heavily-constructed line passing through the ranges, and having one tunnel and four large iron bridges. This line is twenty-two miles long, and cost about £150,000. Iron railway bridges at Hamley and Morphett Street, Adelaide, and the Robinson swing bridge, Port Adelaide were also built under the supervision of the late Mr. Wishart, as well as the iron bridges over the Torrens, near the City, also at Frome, Hindmarsh, and Hackney. Larg's Bay pier (coaling and landing place for mail steamers) and railway, and numerous other bridges, buildings, jetties, wharves, are additional monuments to Mr. Wishart's constructive ability. In brief, the following more or less important works throughout Australia were undertaken and carried out by Mr. Wishart, sen.:-

In Victoria – The first section of the Melbourne water supply, from Preston to Kangaroo Ground, costing about £110,000 ; and numerous smaller works in the early days.

In Tasmania – The road bridge over the Derwent River, £20,000 ; and the Mount Cameron water race, £26,000.

In Western Australia – Jetties at Albany, £25,000 ; Fremantle, £12,000 ; Carnarvon, £10,000 ; Busselton, £8,000 ; Broome, £30,000 (this last work includes a tramway and water supply) and smaller ones at Esperance Bay and Euela. Railway bridge at Guildford, £10,000 ; and the Cape Leeuwin lighthouse, a masonry structure, 145 feet high carrying a Chance's first-order dioptric light, visible 28 miles. The freestone for the masonry was procured from a quarry about half a mile away.

In New South Wales – Dry docks on the Clarence and Tweed Rivers, and the Cowra Bridge. The latter is a unique structure, the three large spans being 165 feet, resting on cylinders sunk 50 feet into the ground by the airlock system. The top cords and braces are of ironbark timber, and the bottom cords are of steel. The approach truss spans are 90 feet. Since coming to Fiji the firm renewed and extended the Queen's Wharf, Suva, and also the Queen's Wharf, Levuka; erected the Wakaya lighthouse; Sabeto bridge, and numerous bridges on Viti Levu, Ovalau, and Vanua Levu. The firm, which consists of the late Mr. Wishart's two sons, started as timber merchants in 1902, and later bought out the old-established business of Messrs. J. C. Smith & Co.

Mr. Wishart died at Suva, on July 20, 1906.

4.3 Creative or Technical Achievement

The Chance Brothers' design for the optical apparatus installed at Cape Leeuwin specified a large lens of 290 cm diameter (114 inches) consisting of a small number of large optical panels, which needed a powerful paraffin burner, and that the apparatus should rotate at high speed to produce a quarter second flash every 5 seconds [9]. This was achieved by placing two bullseyes directly opposite to each other across the turntable. Up until this time lighthouse optical apparatus was typically supported on a “chariot-wheel” system. These wheels were rollers that, even when regularly lubricated, required a powerful clockwork motor to keep the lens rotating evenly, even at a slow speed. As lenses became larger and heavier the rotation time for the light became longer. French designers developed a solution to this problem in the late 1870s when they invented a mercury bath to replace the rollers. The French called this new system ‘feu écalir’ or 'lightning flash' [9]. Chance Brothers adopted and adapted this type of mechanism. The Cape Leeuwin light was their first implementation of this technology worldwide, and the rotation speed was claimed to be twice that of the French systems implemented to that date [9].

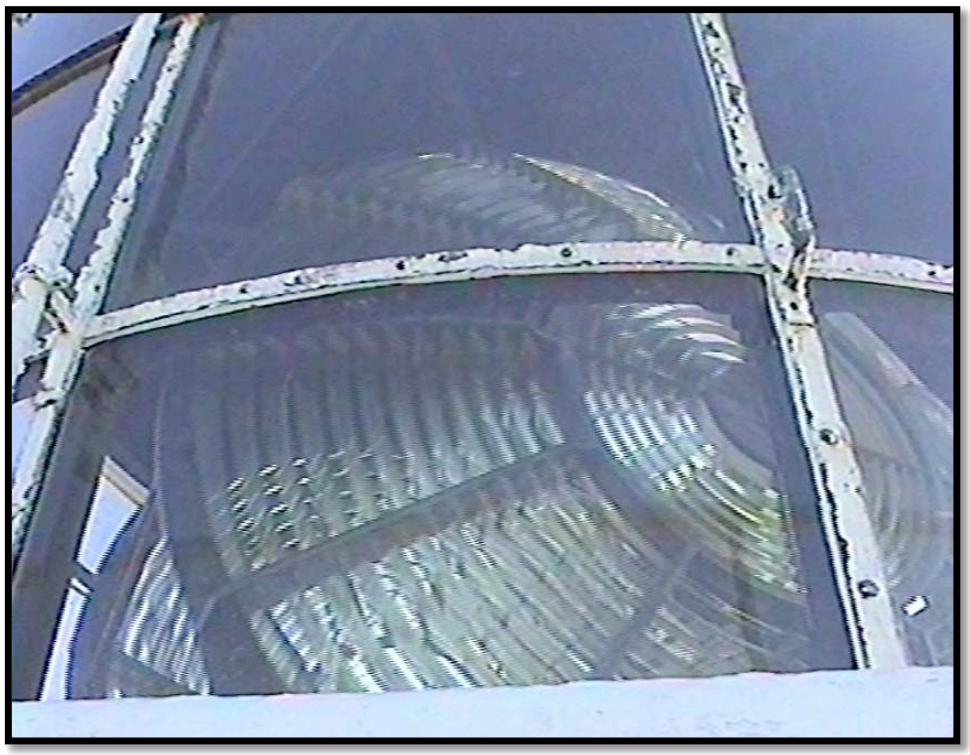

Figure 8. The massive Fresnel lens structure in the Cape Leeuwin Lighthouse, showing the two bullseyes (See description of Fresnel lens in Sect 4.2 - Chance Brothers) (Photo: Mark Bush)

Illumination was initially provided by an Argand lamp that operated on a system of concentric wicks that burnt kerosene or mineral oil. The burning wick produced a light intensity of 200,000 candelas and was visible for approximately 20 nautical miles [13]. The higher the number of wicks used, the greater the illumination. At the time of its installation, the Cape Leeuwin light was the most powerful light in Australia [14]. The lens systems designed by Chance Brothers in both lighthouses are still in operation today.

The Cape Leeuwin lighthouse and quarters are located on a rocky promontory and have no immediate access to a fresh water supply. However, a ready supply of surface water flows from surrounding scrub onto the beach some distance from the lighthouse. The problem of moving that water to the light-keepers' quarters was solved by installing a pump on the beach, driven by a small water wheel. This allowed the high flow rate of water onto the beach over the wheel to be used to pump a small amount of fresh water under pressure to the quarters some distance away and 20m higher.

Figure 9. The Cape Leeuwin Water Wheel, c. 1940. (Photo: State Library of Western Australia).

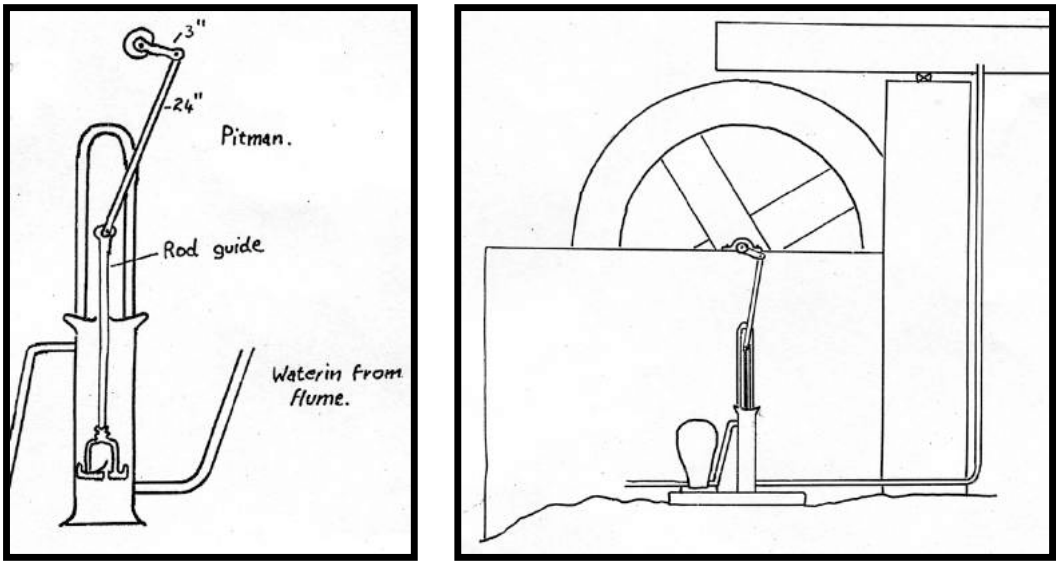

Figure 10. Sketches of the waterwheel and pump operation.
(State Heritage Office of Western Australia, file no. 0106)

The Cape Naturalist light-room was fitted with optical equipment similar to that at Cape Leeuwin, but with a different flash characteristic: Group 2 flash every 10 seconds (two flashes in quick succession every 10 seconds). This was achieved by placing two bullseyes adjacent to each other on one side of the turntable, so that the bullseyes pass by the light in quick succession (See design diagrams in the Appendix - Cape Naturalist Lighthouse). By that time (1903) the power of the lamp had increased to 755,000 candelas. The Cape Leeuwin lamp had also been upgraded to reflect the latest lamp technology and brightness at that time.

In later years the lamps in both lighthouses were upgraded from oil to vaporised kerosene, then to electric incandescent lights, and subsequently converted to automatic operation, according to the schedule indicated in Section 3.1.

4.4 Research Potential

The Chance Brothers lenses are still in operation in both lighthouses - these are pieces of precision engineering equipment which have continued in perfect working order since 1896 (Cape Leeuwin) and 1903 (Cape Naturaliste).

Much of the clockwork mechanism used to rotate the light at Cape Leeuwin is still in place and visible to visitors. The mechanism at Cape Naturaliste has been removed from the lighthouse, but is located in the museum where it can be viewed in detail by visitors.

The Keepers Quarters' were occupied for nearly 100 years at Cape Leeuwin and 75 years at Cape Naturaliste. The archaeological information retained beneath the floorboards of the cottages and in the refuse dumps, could provide invaluable information about the lives and habits of these isolated families.

4.5 Social Significance

The lighthouses were built to support coastal shipping, making it safer and more reliable, which encouraged the development of local industries and subsequent growth and prosperity of communities. These two lighthouses, in particular, were particularly instrumental in the growth of the timber industry in south-western Australia, which relied on ships to transport the heavy cargoes. The Cape Leeuwin lighthouse was important for the safety of shipping passing by the south-western corner of the continent on its way to the eastern settlements.

Today, the lights continue to operate for the benefit of coastal shipping and leisure-craft, and the precincts are highly valued tourist attractions.

4.6 Rarity

This pair of closely associated lighthouses are two of only 4 remaining stone lighthouse structures in Western Australia. The Cape Leeuwin lighthouse is one of the tallest stone light towers in Australia and the tallest on the mainland.

The lighthouse and Keepers' quarters represent a way of life that is no longer practiced today. Keepers maintained the lamp through the night and also played a vital role in maintaining weather and shipping records. The three cottages at each precinct where they lived are a reminder of a once labour-intensive job and the number of people required to keep the lights operational.

4.7 Representativeness

The lighthouses are excellent examples of the stone tower design that was regularly used by many states and countries as the form most suitable to house the lens and light source that make up a lighthouse. Chance Brothers lenses were used in most of Australia's lighthouses. The stone keepers' quarters and utility buildings (oil store, laundries) are representative examples of residences designed for public servants in the late 19th and early 20th century. The service buildings built at later times as technology developed, and now preserved, are representative of the types of utilitarian buildings constructed during the 1940s and 1970s.

4.8 Integrity/Intactness

The condition of all light-station buildings and equipment is excellent. Visitors can see the original Chance Brothers lens systems in position at both sites. At Cape Leeuwin visitors can observe the original clockwork mechanism in situ and see how the light system was subsequently automated.

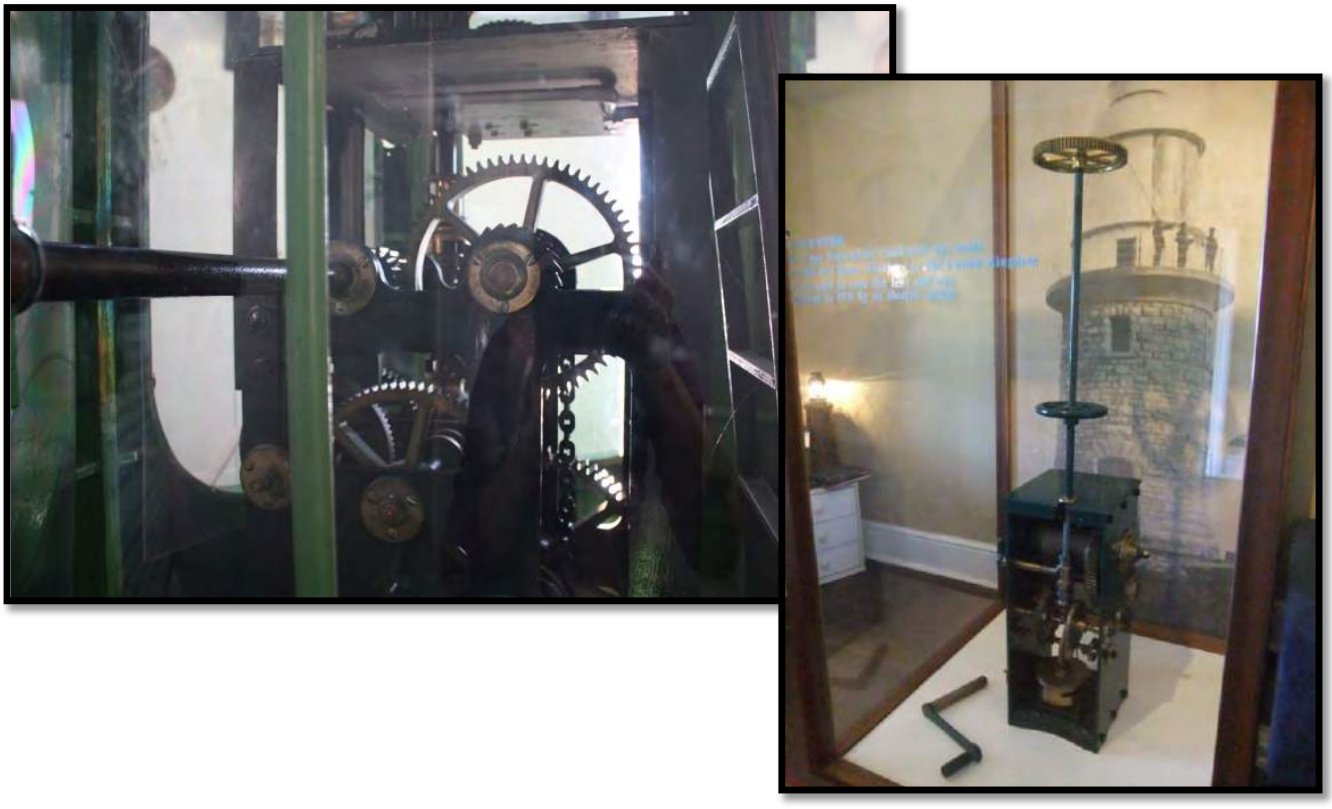

Figure 11. The clockwork mechanism in-situ at Cape Leeuwin (Left; photo: Fiona Bush) and the one at Cape Naturaliste in the museum (Right; photo: Frances Andrich)

The waterwheel at Cape Leeuwin is not operational, being covered with a heavy coating of limestone precipitated from the water supply to the wheel. However, the original wheel mechanism and remains of the pump are recognisable. In the mid 1920s an oil engine was used to assist in pumping water up to the keepers' quarters and in later years the wheel was completely bypassed when a motor was directly linked to the hydraulic ram. The water supply became redundant in 1978 when the lighthouse site was connected to the Augusta town water

supply. The water supply channel to the wheel was refurbished in the 1970s to maintain the water supply as a tourist attraction.

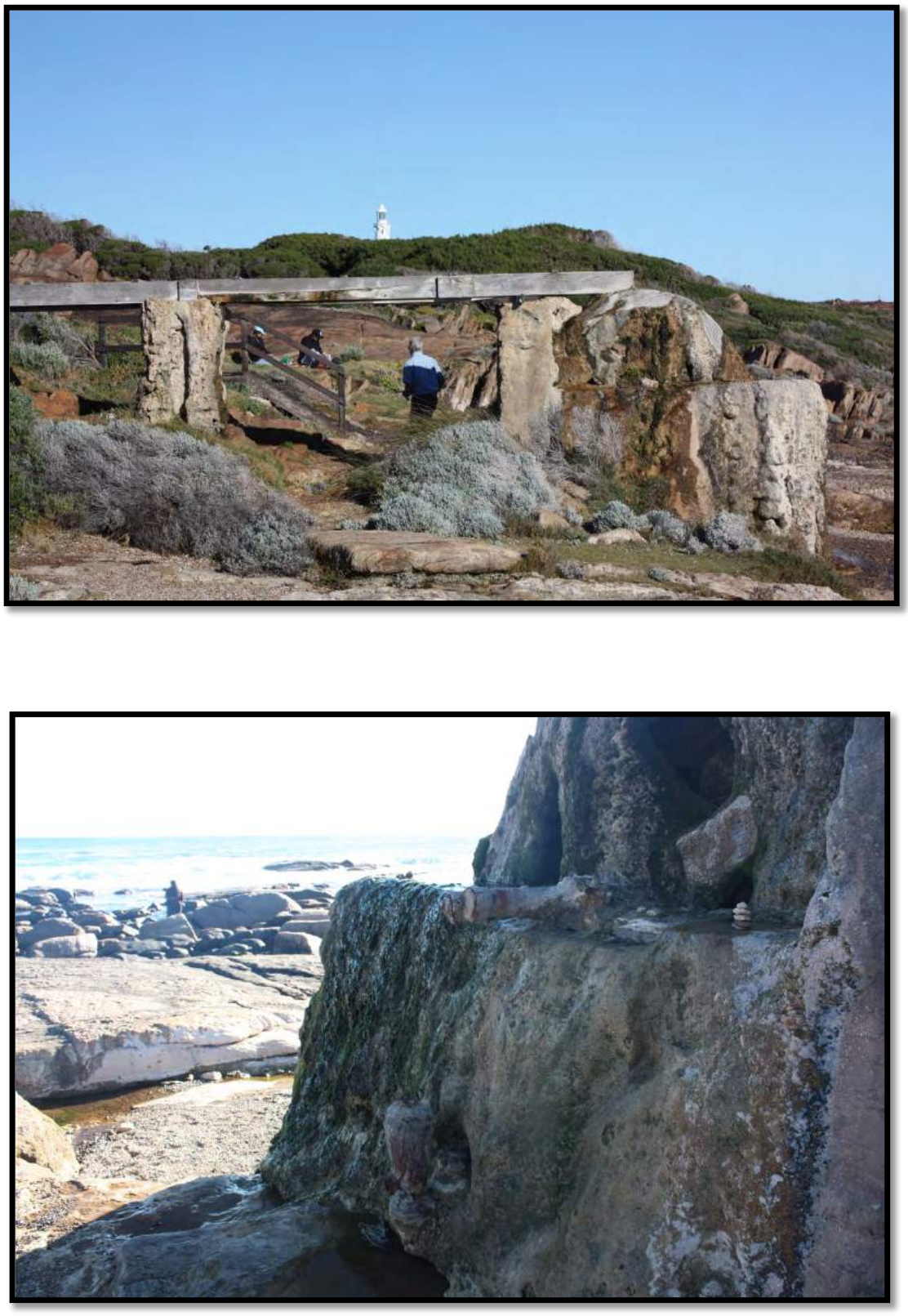

Figure 12. The current state of the water wheel. The lighthouse is just visible in the background in the upper image. The encrusted remains of the crank mechanism and pump can be seen in the lower image. (Photos: Fiona Bush)

4.9 Statement of Significance

The closely associated Cape Leeuwin and Cape Naturaliste Lighthouse precincts, each containing a stone lighthouse, keepers' quarters (stone) and various service buildings, has engineering heritage significance for the following reasons:

- The places are part of a system of coastal lights that was developed at the end of the nineteenth century by the various Australian colonies to improve the safety of shipping operating in Australian territorial waters. Although recognised as being of major importance to the eastern colonies, they were fully funded by the Government of Western Australia;

- The lighthouses were historically important to the local timber industry which relied on ships to transport the timber to other ports. The lights were valuable navigational aides, reducing loss of cargoes and lives;

- The lights were important for safe passage of vessels from Europe to the eastern side of the continent;

- The places, in particular the lighthouses, have retained a high degree of authenticity and integrity;

- the places have aesthetic value both in design and as striking landmarks on the south western coast;

- the places are socially important to the people of Augusta-Margaret River for their tourist potential;

- The places represent a way of life that is no longer practiced in Australia and one which is scarce in other parts of the world. They have the potential to reveal archaeological evidence about how people lived in isolated conditions;

- the lighthouses are fine examples of the type of stone towers erected during the nineteenth century to house lights. The Cape Leeuwin lighthouse tower is the tallest in mainland Australia, and third tallest in the country;

- At the time of its installation, the Cape Leewin light had the most powerful lamp in Australia, and the fastest flash frequency in the world;

- The mercury bath technology employed at both sites was new at the time, and in the case of Cape Leeuwin was the first implementation of the technology by Chance Brothers anywhere in the world, demonstrating a significant advance in flash frequency in large lens systems;

- The significance of these sites is comparable to the Green Cape Lightstation, which has been awarded EHNL recognition;

5. Interpretation Plan

The precincts are operated as tourist attractions by the *Margaret River Busselton Tourism Association (MRBTA)*. The Association fully supports the nomination. The MRBTA Asset and Environment Manager, Mr Mark Delane, has indicated that the Association will be pleased to house and display the marker discs and further interpretation (if required).

Both sites include a Visitors' Centre and museum. At Cape Leeuwin these are housed in the Keeper's cottage closest to the car park (Fig. 2). Visitors can walk the site to look at the buildings and ascend the lighthouse tower. The other Keepers' cottages retain their original appearance and character, and are used to provide accommodation for visitors. Interpretation panels are distributed throughout the grounds as visitors walk to the tower, and within the museum and the tower.

Figure 13. A view through the precinct at Cape Leeuwin. Interpretation panels can be seen distributed along the road to the lighthouse. (Photo: Fiona Bush)

Figure 14. A typical interpretation panel at Cape Leeuwin.

At Cape Naturaliste the Visitors' Centre is also housed in one of the Keepers' cottages, the museum in another. The museum is currently (2018) closed for renovation and upgrading of the interpretation, however the Association has provided an Interpretation Plan indicating how it is intended to look when finished. The Interpretation Plan indicates that the new interpretation at the site will be quite comprehensive, describing some of the people involved in the design and construction (e.g. Chance Brothers) and the lighthouse technology, its value to shipping and community development, as well as the social aspects of life at the lighthouse for the Keepers and their families.

Due to the high standard of the current (and planned) interpretation, it is proposed that the marker discs be mounted in the museum at each site together with a mini-panel highlighting key points noted in the Statement of Significance and some details of the Historic Individuals involved. Development of such mini-panels will need to be done in conjunction with the MRBTA, after the upgrade to the interpretation has been completed.

6. References

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7. Acknowledgements, Authorship

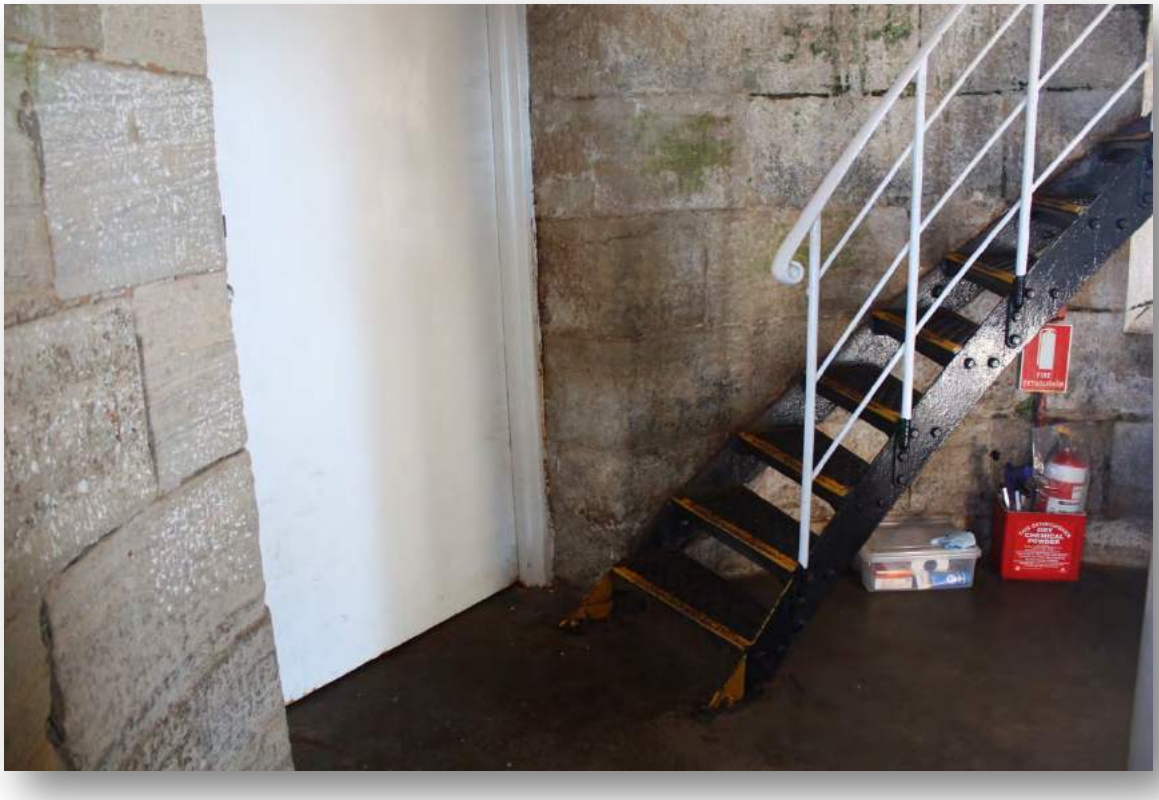
We thank the Margaret River Busselton Tourism Association Asset and Environment Manager, Mr Mark Delane, for his support of this nomination.

Authors: Mark and Fiona Bush, 2018.

APPENDIX - Additional Photos and Diagrams

(Except where noted, photos by Fiona Bush, 2018)

Cape Leeuwin Lighthouse



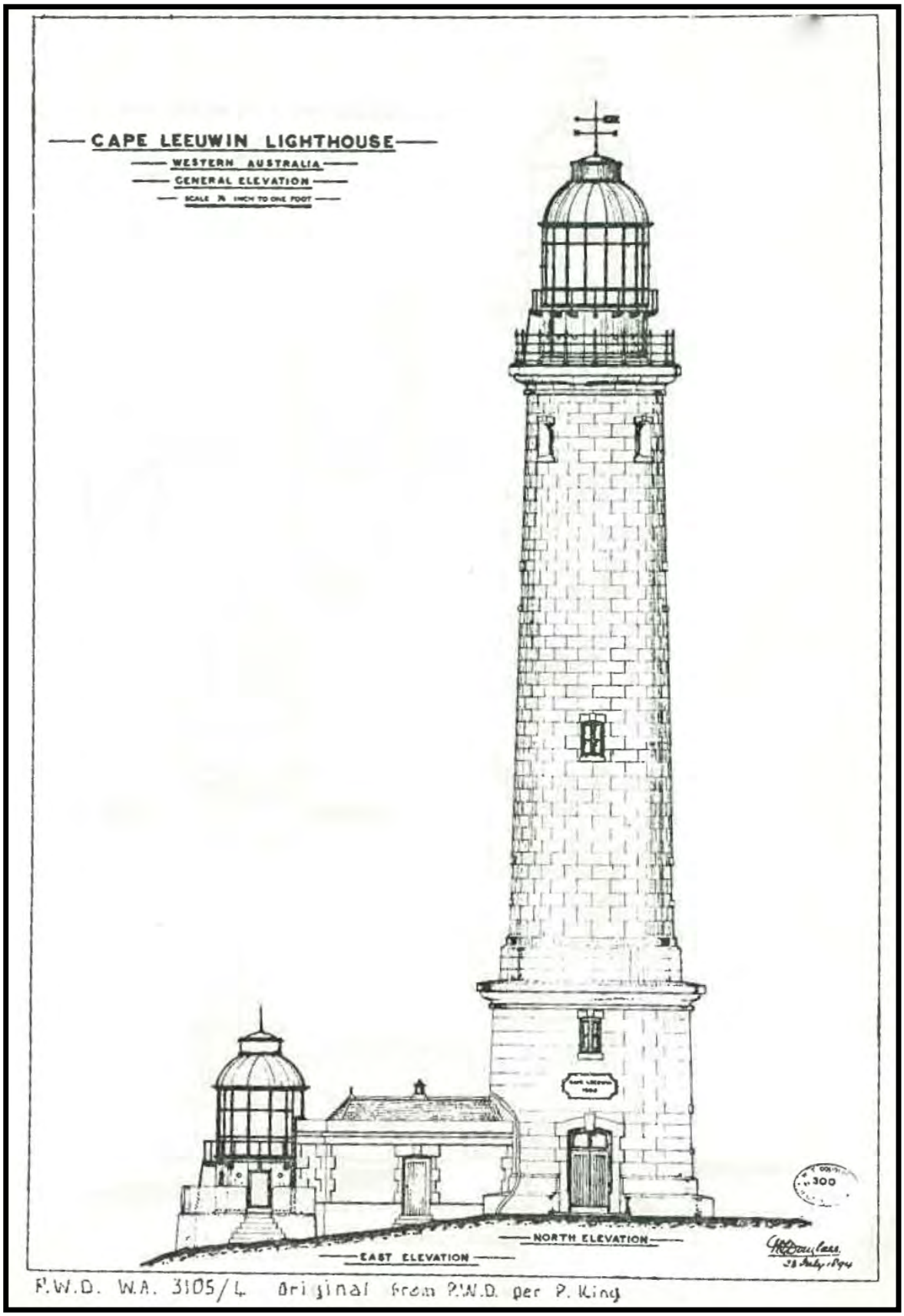


Image from Reference [4]

Cape Naturaliste Lighthouse

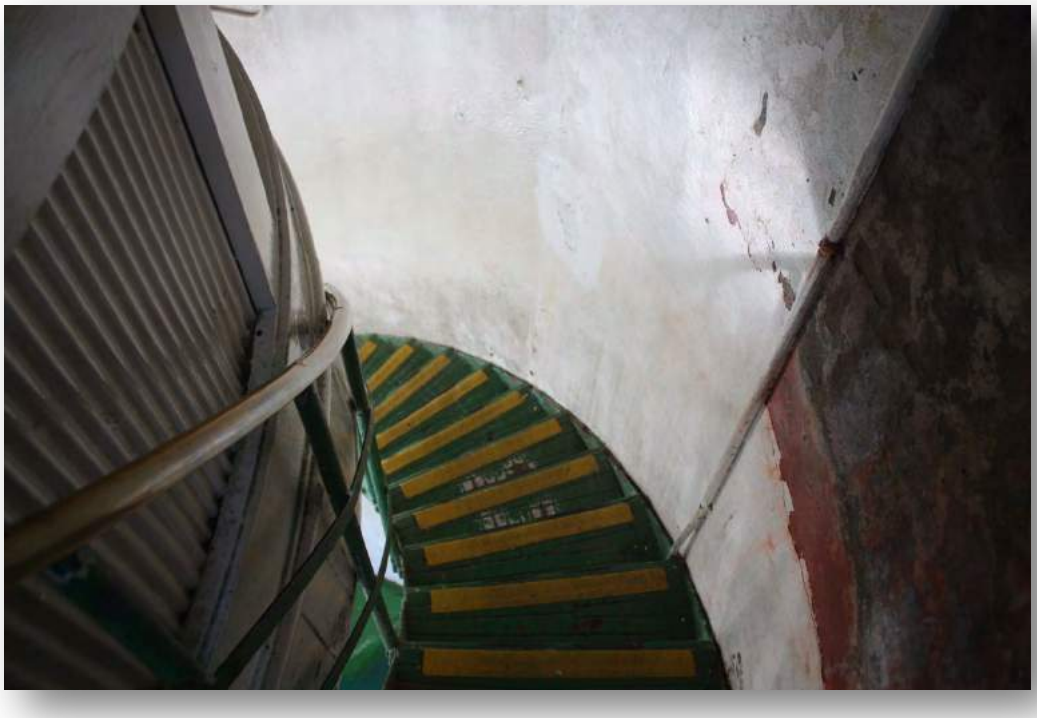
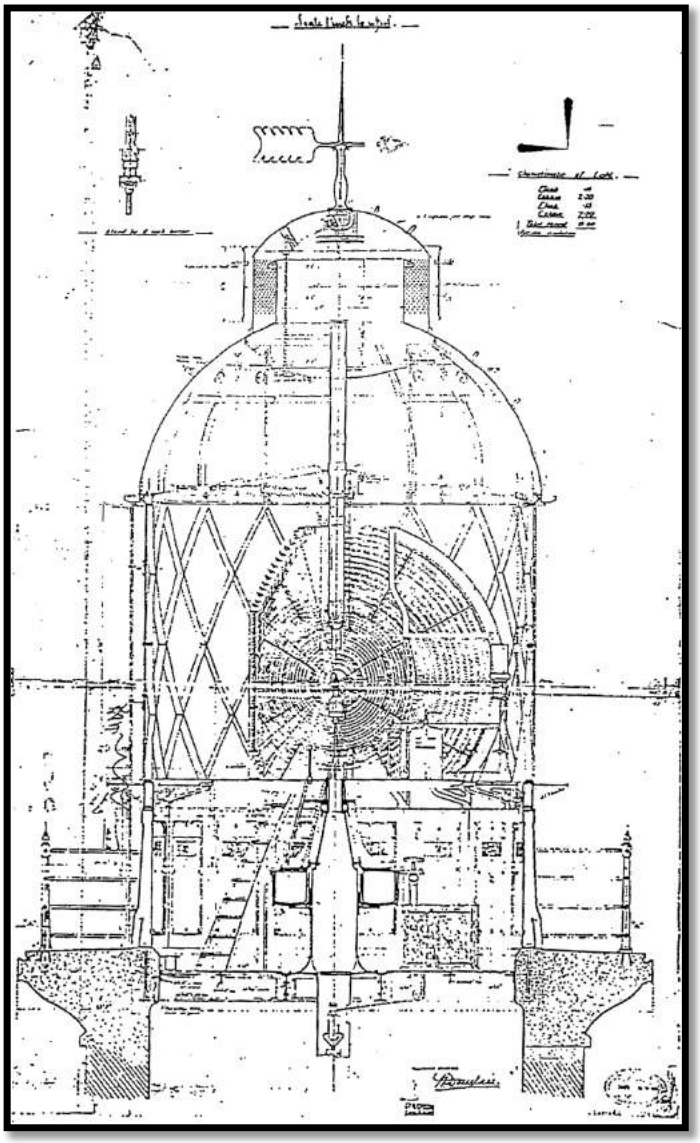
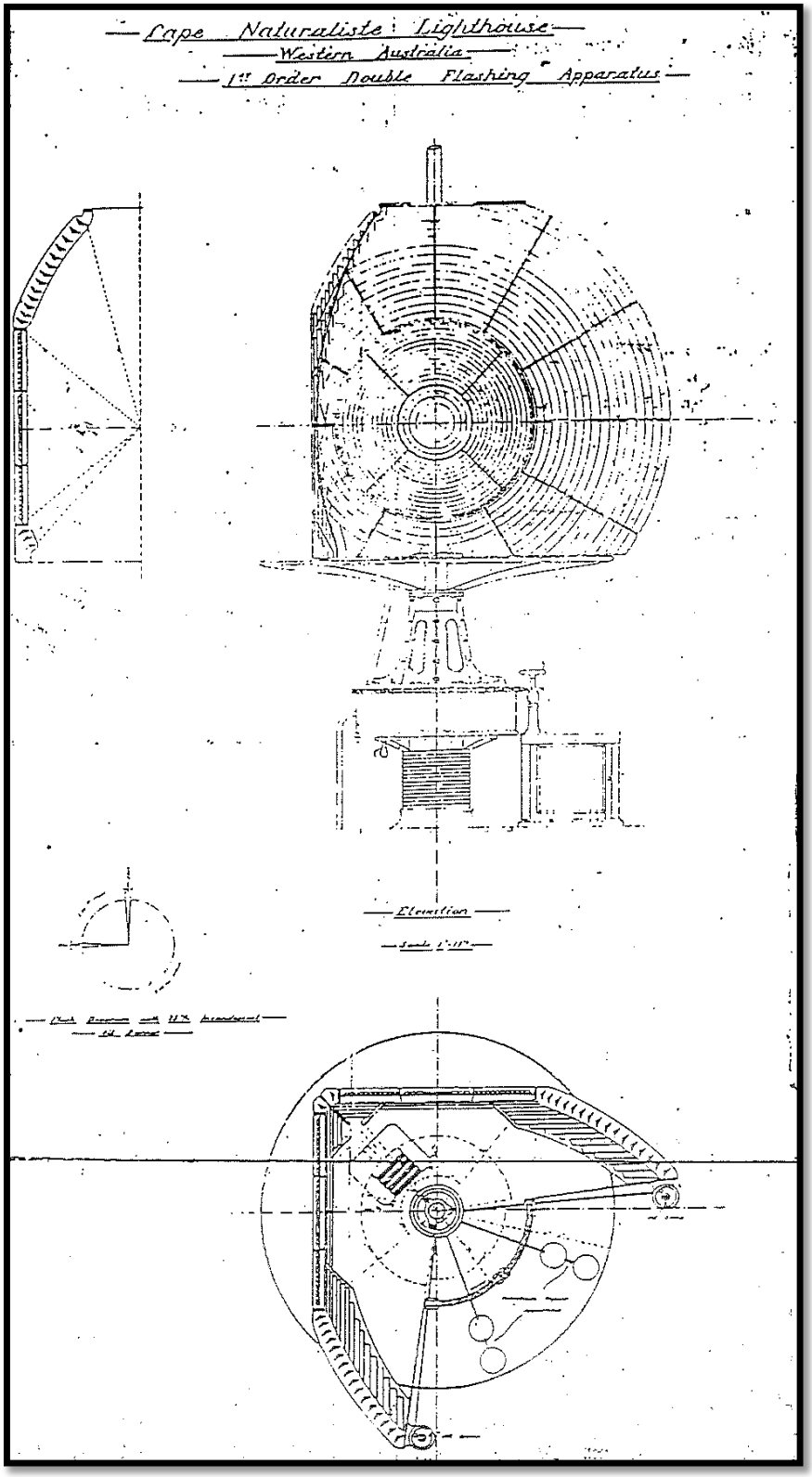


Photo: Frances Andrich



Design drawing for optical system (Image courtesy of Australian Maritime Safety Authority)



Design drawing for Fresnel lens structure. The bullseye positions are best seen in the plan drawing at the bottom. The bullseyes are aligned at 90 degrees and join at one side of the turntable. (Image courtesy of Australian Maritime Safety Authority)